

1 WHAT IS CLAIMED IS

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1. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

10 (a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-
15 dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked; and

(c) measuring temporal features and spatial features of the image from the motion trajectory which
20 is acquired as the three-dimensional volume data by said step (b).

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2. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

30 (a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-
35 dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

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1 (c) acquiring a plane histogram of one of
tangent planes tangent to the motion trajectory and
partial planes which may be included in the motion
trajectory; and

5 (d) measuring temporal features and spatial
features of the image from the plane histogram which
is acquired by said step (c).

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4.
3. A method for extracting image features
from an image sequence in which frames indicating
images are time-sequentially arranged with respect to
15 time, said method comprising the steps of:

(a) inputting the image sequence;

(b) acquiring a motion trajectory of an image
contour of a target included within a region defined
by an arbitrary spatial range and time range within
20 the image sequence input by said step (a), as three-
dimensional volume data drawn within a spatiotemporal
space in which each of the frames is time-sequentially
stacked;

(c) acquiring a plane histogram of tangent
25 planes tangent to the motion trajectory;

(d) estimating a velocity component of the
target which moves within the region from the plane
histogram acquired by said step (c);

(e) extracting a distribution of the tangent
30 planes corresponding to the image contour of the
target which moves at the velocity component estimated
by said step (d), from the plane histogram acquired by
said step (c); and

(f) acquiring spatial features of the image from
35 the distribution of the tangent planes extracted by
said step (e).

1 ⁵/₄. The method as claimed in claim ⁴/₃,
wherein said step (d) includes the substeps of:
 (d1) acquiring a histogram of intersection lines
of the tangent planes from the plane histogram
5 acquired by said step (c); and
 (d2) acquiring, as image features, a most
dominant translational velocity component of the
target which moves within the defined region, from the
histogram of the intersection lines acquired by said
10 substep (d2).

15 ⁶/₅. The method as claimed in claim ⁴/₃,
wherein said step (d) includes the substeps of:
 (d1) acquiring a histogram of intersection lines
of the tangent planes from the plane histogram
acquired by said step (c); and
20 (d2) detecting a plurality of peaks from the
histogram of the intersection lines acquired by said
substep (d1);
 (d3) acquiring velocity components of a plurality
of motions within the region corresponding to the
25 plurality of peaks detected by said substep (d2); and
 (d4) judging whether or not each of the velocity
components can be represented by a composite velocity
of other velocity components, with respect to the
velocity components acquired by said substep (d3), and
30 outputting an independent velocity component which
cannot be represented by the composite velocity of the
other velocity components.

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⁷/₆. The method as claimed in claim ⁴/₃,

1 wherein said step (e) extracts a distribution of
tangent planes along tangent line directions to the
image contour of the target, and said step (f)
calculates feature values related to a directionality
5 of the image contour of the target from the
distribution of the tangent planes extracted by said
step (e).

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8. The method as claimed in claim 4,
wherein said step (e) extracts a distribution of
tangent planes in directions perpendicular to a
15 direction of the image contour of the target, and said
step (f) extracts features related to a spatial
arrangement of the image contour of the target.

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11. A method for extracting image features
from an image sequence in which frames indicating
images are time-sequentially arranged with respect to
25 time, said method comprising the steps of:
(a) inputting the image sequence;
(b) acquiring a motion trajectory of an image
contour of a target included within a region defined
by an arbitrary spatial range and time range within
30 the image sequence input by said step (a), as three-
dimensional volume data drawn within a spatiotemporal
space in which each of the frames is time-sequentially
stacked;
(c) acquiring a plane histogram of tangent
35 planes tangent to the motion trajectory;
(d) acquiring a histogram of intersection lines
of the tangent planes from the plane histogram

1 acquired by said step (c);

(e) detecting a plurality of peaks from the histogram of the intersection lines acquired by said step (d); and

5 (e) acquiring a plurality of velocity components of motions within the region corresponding to the plurality of peaks detected by said step (e).

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¹² 8. The method as claimed in claim ¹¹ 8, which further comprises the steps of:

(f) judging whether or not each of the velocity
15 components can be represented by a composite velocity of other velocity components, with respect to the plurality of velocity components acquired by said step (e); and

(g) outputting an independent velocity component
20 which cannot be represented by the composite velocity of the other velocity components.

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¹⁵ 10. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

30 (a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-
35 dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

1 (c) acquiring a plane histogram of one of
tangent planes tangent to the motion trajectory and
partial planes which may be included in the motion
trajectory;

5 (d) acquiring a normal flow histogram of normal
flows of the image from the plane histogram acquired
by said step (c); and

(e) acquiring temporal features of the image
from the normal flow histogram acquired by said step
10 (d).

15 ¹⁶ 11. The method as claimed in claim ¹⁵ 10,
wherein said step (d) acquires a normal flow histogram
having direction and velocity of the normal flows as
variables, and said step (e) calculates spreading of
the normal flow histogram as feature values
20 representing motion uniformity of the image.

25 ¹⁷ 12. The method as claimed in claim ¹⁵ 10,
wherein said step (d) acquires a normal flow histogram
having velocity of the normal flows as a variable, and
said step (e) calculates a ratio of totalled frequency
value corresponding to normal flows having specific
30 velocities with respect to a totalled frequency value
as a whole as feature values representing the motion
of the image.

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²⁰
18. A method for extracting image features

- 1 from an image sequence in which frames indicating
images are time-sequentially arranged with respect to
time, said method comprising the steps of:
- (a) inputting the image sequence;
 - 5 (b) acquiring a motion trajectory of an image
contour of a target included within a region defined
by an arbitrary spatial range and time range within
the image sequence input by said step (a), as three-
dimensional volume data drawn within a spatiotemporal
10 space in which each of the frames is time-sequentially
stacked;
 - (c) detecting tangent planes tangent to the
motion trajectory;
 - (d) extracting, as an image, a distribution of
15 the motion trajectory existing on the tangent planes
detected by said step (c); and
 - (e) tracking a motion trajectory on the image
extracted by said step (d) and detecting an occlusion
of the target.

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- ²¹
~~14~~ 21. The method as claimed in claim ²⁰~~13~~,
25 wherein said step (e) includes the substeps of:
- (e1) measuring intermittence along a moving
direction of the motion trajectory; and
 - (e2) detecting the occlusion of the target based
on the intermittence measured by said substep (e1).

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- ²²
~~15~~ 22. The method as claimed in claim ²⁰~~13~~,
35 wherein said step (e) includes the substeps of:
- (e1) measuring statistics of a run length along a
moving direction of the motion trajectory; and

1 (e2) detecting a degree of the occlusion of the
target from the statistics of the run length measured
by said substep (e1).

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23.
16. The method as claimed in claim 13,
wherein said step (c) detects the tangent planes in a
10 form of a histogram of the tangent planes which are
represented as a distribution of votes accumulated in
a plane parameter space obtained by use of a three-
dimensional Hough transform.

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24.
17. The method as claimed in claim 13,
wherein said step (c) detects tangent planes
20 corresponding estimated velocity components.

25 18. The method as claimed in ^{claim 1} ~~any of claims~~
~~1, 2, 3, 8, 10 and 13~~, wherein the three-dimensional
volume data is obtained by forming difference images
among the frames in time sequence, and stacking the
formed difference images.

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2.
19. The method as claimed in ^{claim 1} ~~any of claims~~
35 ~~2, 3, 8 and 10~~, wherein the plane histogram is
obtained as votes accumulated in a plane parameter
space obtained by use of a three-dimensional Hough

1 transform.

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20. An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

10 first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means,

15 as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked; and

third means for measuring temporal features and spatial features of the image from the motion

20 trajectory which is acquired as the three-dimensional volume data by said second means.

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26.

21. An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

30 first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means,

35 as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

1 third means for acquiring a plane histogram of
one of tangent planes tangent to the motion trajectory
and partial planes which may be included in the motion
trajectory; and

5 fourth means for measuring temporal features and
spatial features of the image from the plane histogram
which is acquired by said third means.

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29.
22. An equipment for extracting image
features from an image sequence in which frames
indicating images are time-sequentially arranged with
15 respect to time, said equipment comprising:

first means for inputting the image sequence;

second means for acquiring a motion trajectory of
an image contour of a target included within a region
defined by an arbitrary spatial range and time range
20 within the image sequence input by said first means,
as three-dimensional volume data drawn within a
spatiotemporal space in which each of the frames is
time-sequentially stacked;

third means for acquiring a plane histogram of
25 tangent planes tangent to the motion trajectory;

fourth means for estimating a velocity component
of the target which moves within the region from the
plane histogram acquired by said third means;

fifth means for extracting a distribution of the
30 tangent planes corresponding to the image contour of
the target which moves at the velocity component
estimated by said fourth means, from the plane
histogram acquired by said third means; and

sixth means for acquiring spatial features of the
35 image from the distribution of the tangent planes
extracted by said fifth means.

1 ³⁰
~~23~~. The equipment as claimed in claim ²⁹
~~22~~,
wherein said fourth means includes:

seventh means for acquiring a histogram of
intersection lines of the tangent planes from the
5 plane histogram acquired by said third means; and

eighth means for acquiring, as image features, a
most dominant translational velocity component of the
target which moves within the defined region, from the
histogram of the intersection lines acquired by said
10 seventh means.

15 ³²
~~24~~. The equipment as claimed in claim ²⁹
~~22~~,
wherein said fourth means includes:

seventh means for acquiring a histogram of
intersection lines of the tangent planes from the
plane histogram acquired by said third means; and

20 eighth means for detecting a plurality of peaks
from the histogram of the intersection lines acquired
by said seventh means;

ninth means for acquiring velocity components of
a plurality of motions within the region corresponding
25 to the plurality of peaks detected by said eighth
means; and

tenth means for judging whether or not each of
the velocity components can be represented by a
composite velocity of other velocity components, with
30 respect to the velocity components acquired by said
ninth means, and outputting an independent velocity
component which cannot be represented by the composite
velocity of the other velocity components.

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1 ³³
25. The equipment as claimed in claim ²⁹~~22~~,
wherein said fifth means extracts a distribution of
tangent planes along tangent line directions to the
image contour of the target, and said sixth means
5 calculates feature values related to a directionality
of the image contour of the target from the
distribution of the tangent planes extracted by said
fifth means.

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³⁴
26. The equipment as claimed in claim ²⁹~~22~~,
wherein said fifth means extracts a distribution of
15 tangent planes in directions perpendicular to a
direction of the image contour of the target, and said
sixth means extracts features related to a spatial
arrangement of the image contour of the target.

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³⁷
27. An equipment for extracting image
features from an image sequence in which frames
25 indicating images are time-sequentially arranged with
respect to time, said equipment comprising:
first means for inputting the image sequence;
second means for acquiring a motion trajectory of
an image contour of a target included within a region
30 defined by an arbitrary spatial range and time range
within the image sequence input by said first means,
as three-dimensional volume data drawn within a
spatiotemporal space in which each of the frames is
time-sequentially stacked;
35 third means for acquiring a plane histogram of
tangent planes tangent to the motion trajectory;
fourth means for acquiring a histogram of

1 intersection lines of the tangent planes from the
plane histogram acquired by said third means;

5 fifth means for detecting a plurality of peaks
from the histogram of the intersection lines acquired
by said fourth means; and

sixth means for acquiring a plurality of velocity
components of motions within the region corresponding
to the plurality of peaks detected by said fifth
means.

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38.
28. The equipment as claimed in claim 27,
15 which further comprises:

seventh means for judging whether or not each of
the velocity components can be represented by a
composite velocity of other velocity components, with
respect to the plurality of velocity components
20 acquired by said fifth means; and

eighth means for outputting an independent
velocity component which cannot be represented by the
composite velocity of the other velocity components.

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40.
29. An equipment for extracting image
features from an image sequence in which frames
30 indicating images are time-sequentially arranged with
respect to time, said equipment comprising:

first means for inputting the image sequence;
second means for acquiring a motion trajectory of
an image contour of a target included within a region
35 defined by an arbitrary spatial range and time range
within the image sequence input by said first means,
as three-dimensional volume data drawn within a

1 spatiotemporal space in which each of the frames is
time-sequentially stacked;

third means for acquiring a plane histogram of
one of tangent planes tangent to the motion trajectory
5 and partial planes which may be included in the motion
trajectory;

fourth means for acquiring a normal flow
histogram of normal flows of the image from the plane
histogram acquired by said third means; and

10 fifth means for acquiring temporal features of
the image from the normal flow histogram acquired by
said fourth means.

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^{41.}
~~30.~~ The equipment as claimed in claim ⁴⁰~~29~~,
wherein said fourth means acquires a normal flow
histogram having direction and velocity of the normal
20 flows as variables, and said fifth means calculates
spreading of the normal flow histogram as feature
values representing motion uniformity of the image.

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^{42.}
~~31.~~ The equipment as claimed in claim ⁴⁰~~29~~,
wherein said fourth means acquires a normal flow
histogram having velocity of the normal flows as a
30 variable, and said fifth means calculates a ratio of
totalled frequency value corresponding to normal flows
having specific velocities with respect to a totalled
frequency value as a whole as feature values
representing the motion of the image.

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45.
1 32. An equipment for extracting image
features from an image sequence in which frames
indicating images are time-sequentially arranged with
respect to time, said equipment comprising:
5 first means for inputting the image sequence;
second means for acquiring a motion trajectory of
an image contour of a target included within a region
defined by an arbitrary spatial range and time range
within the image sequence input by said first means,
10 as three-dimensional volume data drawn within a
spatiotemporal space in which each of the frames is
time-sequentially stacked;
third means for detecting tangent planes tangent
to the motion trajectory;
15 fourth means for extracting, as an image, a
distribution of the motion trajectory existing on the
tangent planes detected by said third means; and
fifth means for tracking a motion trajectory on
the image extracted by said fourth means and detecting
20 an occlusion of the target.

46.
25 33. The equipment as claimed in claim 32,
wherein said fifth means includes:
sixth means for measuring intermittence along a
moving direction of the motion trajectory; and
seventh means for detecting the occlusion of the
30 target based on the intermittence measured by said
sixth means.

47.
35 34. The equipment as claimed in claim 32,
wherein said fifth means includes:

1 sixth means for measuring statistics of a run
length along a moving direction of the motion
trajectory; and

5 seventh means for detecting a degree of the
occlusion of the target from the statistics of the run
length measured by said sixth means.

10 ^{48.}
~~35.~~ The equipment as claimed in claim ⁴⁵~~32~~,
wherein said third means detects the tangent planes in
a form of a histogram of the tangent planes which are
represented as a distribution of votes accumulated in
15 a plane parameter space obtained by use of a three-
dimensional Hough transform.

20 ^{49.}
~~36.~~ The equipment as claimed in claim ⁴⁵~~32~~,
wherein said third means detects tangent planes
corresponding estimated velocity components.

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37. The equipment as claimed in ^{claim 20}~~any of~~
~~claims 20, 21, 22, 27, 29 and 32~~, wherein the three-
30 dimensional volume data is obtained by forming
difference images among the frames in time sequence,
and stacking the formed difference images.

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^{27.}
~~38.~~ The equipment as claimed in ^{claim 21}~~any of~~

1 ~~claims 21, 22, 23, and 29~~, wherein the plane histogram
is obtained as votes accumulated in a plane parameter
space obtained by use of a three-dimensional Hough
transform.

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39. A computer-readable recording medium
10 recorded with a program for causing a computer to
extract image features from an image sequence in which
frames indicating images are time-sequentially
arranged with respect to time, said program
comprising:

15 a first code for causing the computer to input
the image sequence;

a second code for causing the computer to acquire
a motion trajectory of an image contour of a target
included within a region defined by an arbitrary
20 spatial range and time range within the image sequence
input by said first code, as three-dimensional volume
data drawn within a spatiotemporal space in which each
of the frames is time-sequentially stacked; and

a third code for causing the computer to measure
25 temporal features and spatial features of the image
from the motion trajectory which is acquired as the
three-dimensional volume data by said second code.

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51.

40. A computer-readable recording medium
recorded with a program for causing a computer to
extract image features from an image sequence in which
35 frames indicating images are time-sequentially
arranged with respect to time, said program
comprising:

1 a first code for causing the computer to input
the image sequence;

a second code for causing the computer to acquire
a motion trajectory of an image contour of a target
5 included within a region defined by an arbitrary
spatial range and time range within the image sequence
input by said first code, as three-dimensional volume
data drawn within a spatiotemporal space in which each
of the frames is time-sequentially stacked;

10 a third code for causing the computer to acquire
a plane histogram of one of tangent planes tangent to
the motion trajectory and partial planes which may be
included in the motion trajectory; and

a fourth code for causing the computer to measure
15 temporal features and spatial features of the image
from the plane histogram which is acquired by said
third code.

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54.
41. A computer-readable recording medium
recorded with a program for causing a computer to
extract image features from an image sequence in which
25 frames indicating images are time-sequentially
arranged with respect to time, said program
comprising:

a first code for causing the computer to input
the image sequence;

30 a second code for causing the computer to acquire
a motion trajectory of an image contour of a target
included within a region defined by an arbitrary
spatial range and time range within the image sequence
input by said first code, as three-dimensional volume
35 data drawn within a spatiotemporal space in which each
of the frames is time-sequentially stacked;

a third code for causing the computer to acquire

1 a plane histogram of tangent planes tangent to the
motion trajectory;

a fourth code for causing the computer to
estimate a velocity component of the target which
5 moves within the region from the plane histogram
acquired by said third code;

a fifth code for causing the computer to extract
a distribution of the tangent planes corresponding to
the image contour of the target which moves at the
10 velocity component estimated by said fourth code, from
the plane histogram acquired by said third code; and

a sixth code for causing the computer to acquire
spatial features of the image from the distribution of
the tangent planes extracted by said fifth code.

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55.
42. The computer-readable recording medium
20 as claimed in claim ~~41~~⁵⁴, wherein said fourth code
includes:

seventh code for causing the computer to acquire
a histogram of intersection lines of the tangent
planes from the plane histogram acquired by said third
25 code; and

an eighth code for causing the computer to
acquire, as image features, a most dominant
translational velocity component of the target which
moves within the defined region, from the histogram of
30 the intersection lines acquired by said seventh code.

57.
43. The computer-readable recording medium
35 as claimed in claim ~~41~~⁵⁴, wherein said fourth code
includes:

1 a seventh code for causing the computer to
acquire a histogram of intersection lines of the
tangent planes from the plane histogram acquired by
said third code; and

5 an eighth code for causing the computer to detect
a plurality of peaks from the histogram of the
intersection lines acquired by said seventh code;

 a ninth code for causing the computer to acquire
velocity components of a plurality of motions within
10 the region corresponding to the plurality of peaks
detected by said eighth code; and

 a tenth code for causing the computer to judge
whether or not each of the velocity components can be
represented by a composite velocity of other velocity
15 components, with respect to the velocity components
acquired by said ninth code, and output an independent
velocity component which cannot be represented by the
composite velocity of the other velocity components.

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58.
44. The computer-readable recording medium
as claimed in claim ~~41~~⁵⁴, wherein said fifth code causes
25 the computer to extract a distribution of tangent
planes along tangent line directions to the image
contour of the target, and said sixth code causes the
computer to calculate feature values related to a
directionality of the image contour of the target from
30 the distribution of the tangent planes extracted by
said fifth code.

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59.
45. The computer-readable recording medium
as claimed in claim ~~41~~⁵⁴, wherein said fifth code causes

1 the computer to extract a distribution of tangent
planes in directions perpendicular to a direction of
the image contour of the target, and said sixth code
causes the computer to extract features related to a
5 spatial arrangement of the image contour of the
target.

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^{61.}
~~48.~~ A computer-readable recording medium
recorded with a program for causing a computer to
extract image features from an image sequence in which
frames indicating images are time-sequentially
15 arranged with respect to time, said program
comprising:

a first code for causing the computer to input
the image sequence;

a second code for causing the computer to acquire
20 a motion trajectory of an image contour of a target
included within a region defined by an arbitrary
spatial range and time range within the image sequence
input by said first code, as three-dimensional volume
data drawn within a spatiotemporal space in which each
25 of the frames is time-sequentially stacked;

a third code for causing the computer to acquire
a plane histogram of tangent planes tangent to the
motion trajectory;

a fourth code for causing the computer to acquire
30 a histogram of intersection lines of the tangent
planes from the plane histogram acquired by said third
code;

a fifth code for causing the computer to detect a
plurality of peaks from the histogram of the
35 intersection lines acquired by said fourth code; and

a sixth code for causing the computer to acquire
a plurality of velocity components of motions within

- 1 the region corresponding to the plurality of peaks
detected by said fifth code.

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⁶²
~~47~~. The computer-readable recording medium
as claimed in claim ⁶¹~~48~~, wherein said program further
comprises:

- 10 a seventh code for causing the computer to judge
whether or not each of the velocity components can be
represented by a composite velocity of other velocity
components, with respect to the plurality of velocity
components acquired by said fifth code; and
15 an eighth code for causing the computer to output
an independent velocity component which cannot be
represented by the composite velocity of the other
velocity components.

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⁶⁵
~~48~~. A computer-readable recording medium
recorded with a program for causing a computer to
25 extract image features from an image sequence in which
frames indicating images are time-sequentially
arranged with respect to time, said program
comprising:

- a first code for causing the computer to input
30 the image sequence;
a second code for causing the computer to acquire
a motion trajectory of an image contour of a target
included within a region defined by an arbitrary
spatial range and time range within the image sequence
35 input by said first code, as three-dimensional volume
data drawn within a spatiotemporal space in which each
of the frames is time-sequentially stacked;

1 a third code for causing the computer to acquire
a plane histogram of one of tangent planes tangent to
the motion trajectory and partial planes which may be
included in the motion trajectory;

5 a fourth code for causing the computer to acquire
a normal flow histogram of normal flows of the image
from the plane histogram acquired by said third code;
and

a fifth code for causing the computer to acquire
10 temporal features of the image from the normal flow
histogram acquired by said fourth code.

15 ^{66.}
~~48.~~ The computer-readable recording medium
as claimed in claim ~~48~~⁶⁵, wherein said fourth code
causes the computer to acquire a normal flow histogram
having direction and velocity of the normal flows as
20 variables, and said fifth code causes the computer to
calculate spreading of the normal flow histogram as
feature values representing motion uniformity of the
image.

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^{67.}
~~50.~~ The computer-readable recording medium
as claimed in claim ~~48~~⁶⁵, wherein said fourth code
30 causes the computer to acquire a normal flow histogram
having velocity of the normal flows as a variable, and
said fifth code causes the computer to calculate a
ratio of totalled frequency value corresponding to
normal flows having specific velocities with respect
35 to a totalled frequency value as a whole as feature
values representing the motion of the image.

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1 ⁷⁰51. A computer-readable recording medium
recorded with a program for causing a computer to
extract image features from an image sequence in which
frames indicating images are time-sequentially
5 arranged with respect to time, said program
comprising:

a first code for causing the computer to input
the image sequence;

a second code for causing the computer to acquire
10 a motion trajectory of an image contour of a target
included within a region defined by an arbitrary
spatial range and time range within the image sequence
input by said first code, as three-dimensional volume
data drawn within a spatiotemporal space in which each
15 of the frames is time-sequentially stacked;

a third code for causing the computer to detect
tangent planes tangent to the motion trajectory;

a fourth code for causing the computer to
extract, as an image, a distribution of the motion
20 trajectory existing on the tangent planes detected by
said third code; and

a fifth code for causing the computer to track a
motion trajectory on the image extracted by said
fourth code and detecting an occlusion of the target.

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30 ⁷¹52. The computer-readable recording medium
as claimed in claim ⁷⁰51, wherein said fifth code
includes:

a sixth code for causing the computer to measure
intermittence along a moving direction of the motion
trajectory; and

35 a seventh code for causing the computer to detect
the occlusion of the target based on the intermittence
measured by said sixth code.

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1 ⁷²
53. The computer-readable recording medium
as claimed in claim ⁷⁰51, wherein said fifth code
includes:

5 a sixth code for causing the computer to measure
statistics of a run length along a moving direction of
the motion trajectory; and

a seventh code for causing the computer to detect
a degree of the occlusion of the target from the
statistics of the run length measured by said sixth
10 code.

15 ⁷³
54. The computer-readable recording medium
as claimed in claim ⁷⁰51, wherein said third code causes
the computer to detect the tangent planes in a form of
a histogram of the tangent planes which are
represented as a distribution of votes accumulated in
20 a plane parameter space obtained by use of a three-
dimensional Hough transform.

25 ⁷⁴
55. The computer-readable recording medium
as claimed in claim ⁷⁰51, wherein said third code causes
the computer to detect tangent planes corresponding
estimated velocity components.

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56. The computer-readable recording medium
35 as claimed in ^{claim 39}any of claims 39, 40, 41, 46, 48 and 51,
wherein the three-dimensional volume data is obtained
by forming difference images among the frames in time

1 sequence, and stacking the formed difference images.

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⁵²
~~57.~~ The computer-readable recording medium
as claimed in ^{claim 40 51} ~~any of claims 40, 41, 42, 46 and 48,~~
wherein the plane histogram is obtained as votes
accumulated in a plane parameter space obtained by use
10 of a three-dimensional Hough transform.

Add B.17

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